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Identification of Promising Resource Recovery Alternatives for the City of Columbus/Muscogee County, Georgia

CSI Resource Systems, Inc.
Boston, MA

Prepared for

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Identification of Promising Resource Recovery Alternatives for the City of Columbus/ Muscogee County, Georgia

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RESOURCE RECOVERY AND CONSERVATION PANELS

SEC. 2003. The Administrator shall provide teams of personnel, including Federal, State, and local employees or contractors (hereinafter referred to as "Resource Conservation and Recovery Panels") to provide States and local governments upon request with technical assistance on solid waste management, resource recovery, and resource conservation. Such teams shall include technical, marketing, financial, and institutional specialists, and the services of such teams shall be provided without charge to States or local governments.

This report has been reviewed by the Project Officer, EPA, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Project Officer: Elmer G. Cleveland

IDENTIFICATION OF PROMISING RESOURCE RECOVERY ALTERNATIVES FOR THE CITY OF COLUMBUS/, MUSCOGEE COUNTY, GEORGIA

Prepared for

Office of Solid Waste Management
U.S. Environmental Protection Agency, Region IV

By

CSI Resource Systems, Inc.

October 1981

PREFACE

This report was prepared for the Consolidated Government of Columbus, Georgia, under the Technical Assistance and Panels Program, which is conducted by the U.S. Environmental Protection Agency (EPA) to provide assistance to state and local governments in the areas of solid waste management and resource recovery. Technical assistance was provided in response to a request to U.S. EPA Region IV from the Consolidated Government of Columbus.

The report presents the results of a preliminary determination of the feasibility of resource recovery for the Columbus/Muscogee County, Georgia area. This determination involved development of first-order estimates of the quantity of waste generated by Columbus, Muscogee County and Fort Benning; evaluation of the market potential for energy recovery; development and evaluation of an appropriate resource recovery alternative; a preliminary assessment of the environmental considerations associated with that alternative; and identification of major tasks to be performed prior to deciding to implement a resource recovery project. These activities reflect the results of several site visits to Columbus by CSI Resource Systems, Inc. and interviews with personnel from the Columbus Consolidated Government and interviews with major industrial energy users in the area.

Resource Systems, Inc., is a technical assistance contractor to the Office of Solid and Hazardous Waste, U.S. EPA Region IV. Under the terms of the Technical Assistance and Panels Program, all of CSI's technical assistance activities in behalf of the Consolidated Government were paid for by EPA.

CSI wishes to thank especially the following individuals for their support and generous cooperation: Hans J. Gant, Chief of City Planning; Franklyn Lambert, City Manager; C.L. Moffitt, Assistant City Manager; the Consolidated Government of Columbus; and George (Leo) Schladensky, Chief of Utilities Division, Fort Benning Military Reservation.

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1. OVERVIEW

The City of Columbus, Georgia, is an urban-industrial center of 170,000 people, located along the Chattahooche River, southwest of Atlanta. In 1971, Columbus joined with Muscogee County to form the state's first consolidated government. The Consolidated Government is responsible for residential solid waste collection in the Columbus/Muscogee area. The remaining solid waste (about 50 percent of the area's total) is collected by private haulers or delivered by trucks from various industrial concerns.

The majority of the area's waste is disposed of in a privately owned and operated landfill south of Columbus (Wilson Camp landfill). The Consolidated Government, however, prefers to secure its own landfill for disposal of its waste, as well as to consider resource recovery as a means of possibly minimizing future disposal costs and, more importantly, of extending the life of the new landfill to be acquired. Consequently, the Consolidated Government requested technical assistance from the U.S. EPA to make a preliminary assessment of the feasibility of resource recovery. If one or more projects appeared to be technically feasible and economically promising, the Consolidated Government wished assistance in identifying the immediate next steps to be undertaken.

Subsequent to the technical assistance request, the Consolidated Government received an unsolicited proposal for a resource recovery facility serving the Columbus/Muscogee area. In response to that proposal, the Consolidated Government initiated steps toward establishing a resource recovery authority (permitted under state law) that would be the entity responsible for project implementation should the Consolidated Government decide to pursue resource recovery. Section 7 of this report, Legal/Institutional Issues and Next Steps, addresses the implications of such an authority.

While the technical assistance request involved several areas for improving the Consolidated Government's solid waste management system, because the bulk of the request addressed resource recovery feasibility, the main body of this report summarizes the findings and conclusions of

the preliminary feasibility assessment; results for the other elements of the technical assistance request are reported in Appendices A and B.

In making a preliminary determination of the technical and economic feasibility of resource recovery as a solid waste management option for the Columbus/Muscogee area, the following tasks were performed:

- A preliminary waste weighing program was conducted at the major landfill serving the area and existing weigh data from the Fort Benning Military Reservation was reviewed to determine the quantity of solid waste available to a resource recovery facility.
- An energy market survey was made to identify one or more prospective customers for waste-derived energy.
- A technology assessment was performed and a preliminary system was defined that was appropriate to available waste tonnage and energy requirements of potential buyers.
- First-order capital costs and total financing requirements under two possible financing arrangements were made for each of the technically viable options, preliminary annual debt service requirements, operation and maintenance costs, and energy revenue estimates were made to determine the likely economic viability of each resource recovery alternative.
- A preliminary environmental assessment was made for a resource recovery facility of the size and type that would be appropriate for the Columbus/Muscogee area.
- The legal/institutional issues related to pursuing a resource recovery project were assessed and the next steps that should be undertaken if the Consolidated Government wishes to proceed were identified.

Major findings/conclusions resulting from these tasks are:

- The combined current solid waste generation of the Columbus/Muscogee/Fort Benning area is approximately 505 TPD_7 (tons per day on a 7-day-per-week basis). By 1984, the combined waste generation is estimated to be around 520 TPD_7, or 187,200 tons per year, of which 490 TPD_7, or 176,400 tons per year, could be processed in a resource recovery facility.
- The Consolidated Government collects and thus directly controls only about 50 percent of this total amount.

- The Fort Benning Military Reservation was identified as the most promising potential customer for waste-derived energy.

- The Reservation's energy requirements indicate that process steam is the principal energy form to be considered from a resource recovery facility serving the Columbus area. However, to utilize fully the energy potential of the area's solid waste, cogeneration of steam and electricity (with electricity sold to either Fort Benning or Georgia Power Company) appears to be the most promising option available.

- The projected economics of a 600-TPD (design capacity) cogeneration resource recovery facility appear to be competitive with the option of implementing and operating one or more environmentally complying landfill disposal sites. Depending on the financing method used, the net cost of disposal under this resource recovery alternative ranges from $9.00 to $16.00 per ton in 1984 (the assumed first year of commercial operations) to $2.00 to $9.00 in 1989 (the sixth year of commercial operations). A projected per-ton cost of disposal under continued primary reliance on landfilling ranges from $10.00 to $15.00 in 1984 and $15.00 to $20.00 in 1989.

- It is not anticipated that either a state or a federal Environmental Impact Statement would be required. Air, water use, wastewater discharge, and solid waste disposal permits would be required for a resource recovery facility serving the Columbus/Muscogee area. However, ultimate classification of the facility will influence air permitting requirements and schedules.

- Whether or not Columbus elects to implement a resource recovery project, it should begin steps to secure a new landfill disposal facility to fully comply with recently mandated environmental requirements. A usable landfill is an integral part of a resource recovery system and the City's existing landfill has significant operational and environmental problems. Because the location and acreage requirements of a new disposal site is in part determined by whether a resource recovery system will be implemented, a timely decision relative to resource recovery implementation is essential.

The remainder of this report: addresses the area's current collection and disposal practices, contains findings from the waste weighing program; contains a description of the approach to and findings of the energy market survey; describes the two resource recovery options evaluated; contains the projected economics of each resource recovery option

evaluated; includes a discussion of the environmental requirements for a resource facility of the scale and technology found appropriate to meet the energy requirements of Fort Benning and the disposal needs of the Columbus/Muscogee area; and contains a discussion of the legal and institutional issues associated with implementation of a regional energy recovery facility as well as an identification of the next steps to be undertaken, if a decision is made to implement an energy recovery project. In addition, possible means of reducing the costs of current municipal collection are contained in Appendix A. The results of the preliminary evaluation of new landfill disposal sites are presented in Appendix B, and the results of the energy market survey are contained in Appendix C.

2. WASTE CHARACTERIZATION

This section discusses current waste collection and disposal practices in the City of Columbus and Muscogee County and at the Fort Benning Military Reservation. In addition, the results of a limited weighing program sponsored by Columbus are given to more accurately define the quantity and sources of waste delivered to the major landfill used by the City and County. Finally, future landfill disposal requirements for Columbus and Muscogee County area are addressed.

CURRENT WASTE COLLECTION AND DISPOSAL PRACTICES

The Consolidated Government of Columbus provides a municipal collection service for all the residents of Columbus and the surrounding incorporated areas of Muscogee County. In addition, the Consolidated Government provides collection services to approximately 1,400 of the commercial establishments located along existing residential routes, via 4- to 8-cubic-yard containers.

The municipal collection fleet is comprised of 25-cubic-yard rear-loading vehicles. Currently, the collection system is staffed by 36 different crews with collection on a twice-per-week curbside basis. Of these 36 crews, 24 are staffed with inmates from the nearby state prison. The current collection schedule is 4 days per week: Monday, Tuesday, Thursday and Friday.

Residents in the unincorporated areas and large commercial and industrial entities make their own arrangements with local private haulers or deliver their wastes to the Wilson Camp landfill, a privately owned disposal site under contract to the Consolidated Government.

The Wilson Camp landfill, which is the major landfill serving the City of Columbus and Muscogee County, is located just south of the city. This site has an estimated remaining useful life of 20 years. However, because of past operation-related difficulties and the landfill's possible encorachment on a flood plain, the facility does not meet the strict environmental requirements mandated by the Resource Conservation and Recovery Act (RCRA) of 1976. As a consequence, the Consolidated Government is

interested in exploring disposal alternatives that are environmentally more suitable.

In addition to the Wilson Camp facility, the Consolidated Government uses the privately owned Tyler landfill for the occasional disposal of limbs, trees, and construction debris.

Fort Benning Military Reservation operates its own landfill, which is located on the Reservation.

ESTIMATED WASTE QUANTITY AND SOURCES

A limited weighing program was conducted to estimate more accurately the quantity of solid waste generated in the Columbus/Muscogee area.

This program consisted of weigh measurements and vehicle arrival counts taken at selected times during the period May 28 through July 21, 1981, at the Wilson Camp landfill.

The following table summarizes current Columbus/Muscogee waste generation by source on a 7-day-per-week basis:

SOURCE	QUANTITY (tons per week)	AVERAGE TPD_7
Municipal Collection Vehicles	1,620	231
Other Large Trucks*	1,560	222
Private Pickups and Autos	50	7
TOTAL:	3,230	461

A limited weighing program conducted at the Fort Benning landfill in 1979 indicated that the Reservation was generating approximately 60 TPD_5.** According to Fort Benning personnel, this figure is expected to

* Private haulers, commercial/industrial trucks, and miscellaneous City vehicles.

** Tons per day on a 5-day-per-week basis.

increase to 80 TPD_5, or 57 TPD_7, by 1984, reflecting additional growth in Reservation population and related activities.

In determining the approximate size for a resource recovery facility serving the disposal needs of the Columbus/Muscogee area, the following assumptions were made:

- Five percent of the waste generated is unprocessible in a resource recovey facility, including oversized bulky waste.
- Per-capita waste generation will remain static (i.e., additional waste growth will result only from increased population, not from increased waste generation per-capita).
- Fort Benning waste, projected to reach 57 TPD_7 by 1984, will also be available as a feedstock for a Columbus resource recovery facility.

Thus, the approximate quantity of solid waste available was calculated as follows:

$$\frac{.95 \text{ processible component } [3{,}230 \text{ (Columbus/Muscogee)} + 400\text{(Fort Benning)}]}{7 \text{ days}}$$

= approximately 490 TPD_7.

It should be noted that no consideration has been given in this report to seasonal variability in waste generation, as neither of the two weigh programs were extensive enough to account for this factor.

FUTURE LANDFILL DISPOSAL REQUIREMENTS

Whether or not the Consolidated Government elects to implement a resource recovery project, it should begin steps to secure a new landfill disposal facility to fully comply with the environmental standards mandated by RCRA. A usable landfill is an integral part of a resource recovery system, and the existing landfill which serves the area has significant operational and environmental problems. Because the location and acreage requirements of a new disposal site is determined in part by whether a resource recovery system is implemented, a timely decision relative to resource recovery implementation is essential.

The Consolidated Government is in the process of identifying potential sites for an environmentally complying landfill disposal facility. In the event that a resource recovery project is implemented, the disposal facility's primary function will be to accommodate residual products and occasional bypassed waste; such a facility would ideally be located near the resource recovery plant in order to minimize residual haul costs.

On the other hand, if resource recovery is not implemented, the appropriate location for a landfill disposal facility would be as close to the centroid of waste generation as possible. For a landfill disposal site located near the envisioned resource recovery facility or for a primary landfill located away from the centroid of waste generation consideration should be given to utilizing a transfer station concept to minimize haul costs.

The major engineering, environmental, legal and regulatory, political and economic considerations that should be addressed in implementing a landfill disposal facility are presented in Appendix B.

3. ENERGY MARKET SURVEY

To identify potential markets for recovered energy within the jurisdiction of the Consolidated Government, initial telephone contact was made with 39 prospective buyers. From information obtained on energy usage and level of interest, the number of prospects to be interviewed was reduced to five. Interviews were held with these five prospects which include Columbus Carpet Mills, Fieldcrest Mills, Fort Benning Military Reservation, Georgia Power Company and Swift Textiles. Of the prospective energy customers surveyed, only Fort Benning was found to meet all of the requisites for consideration as a customer for resource recovered energy. Based on its substantial and continuous requirements for both low-pressure steam and electricity; its reliance on high-priced fuels; the likely availability of suitable sites to locate a facility; its stability as a long-term energy buyer, and its demonstrated interest in exploiting alternative energy opportunities, Fort Benning was identified as an ideal market for resource recovery energy.

The remainder of this section contains a brief description of the approach used to conduct the energy market survey. In addition, the energy requirements of Fort Benning are the preferred energy market. Appendix C gives the survey results for the other four market prospects interviewed.

SURVEY APPROACH

After narrowing the list of prospective buyers down to five, each potential market was assessed according to the following:

- Technical capability to use recovered energy
- Continuity of operations
- Current use of high-cost fuel
- Availability of or proximity to a site suitable for an energy recovery facility
- Proximity to the centroid of the wasteshed

- Stability as a long-term energy buyer
- Interest in resource recovery.

Given that only approximately 490 TPD_7 of waste would be available for processing in a resource recovery facility servicing Columbus/Muscogee, steam production or steam and electricity cogeneration appeared preferable to electricity-only production. Typically, steam production is more cost-effective than electricity-only production. The preliminary economic analysis did, however, include an electricity-only market for reference purposes.

For purposes of waste-derived steam, the most desirable steam customer requires low-pressure, low-temperature steam; has a constant steam demand on a 24-hour-per-day basis and a minimum of 5 days per week throughout the year; and currently uses high-priced fuels in its boilers. A potentially available site should exist within a 1- to 1.5-mile radius, and the customer should be located close to the centroid of the wasteshed to minimize haul costs.

On the basis of these desired characteristics, the preliminary market survey indicated that Fort Benning Military Reservation could be considered a promising customer for energy from Columbus/Muscogee's solid waste. This market is described below.

PREFERRED ENERGY MARKET

The Fort Benning Military Reservation is a major defense installation covering some 280 square miles and located contiguous to the southeastern boundaries of the City of Columbus.

The Reservation is a major energy consumer. Low-pressure steam and high-temperature hot water are produced in five plants on the Reservation with outputs as shown in the following table:

PLANT	RATED CAPACITY	AVERAGE HOURLY PRODUCTION
Main Post	178,000 lb	63,000 lb
Kelly Mill	38,000 lb	19,000 lb
Martin Army Hospital	45,000 lb	16,000 lb
Sand Mill (hot water)	60 MBtu	20 MBtu
Benning Mill	17,500 lb	4,000 lb

These plants are dispersed throughout a 12-square-mile section of the main base area of the Reservation.

Electricity is purchased from Georgia Power Company; in 1980, annual consumption was around 175,000 MW.

Each steam or hot water plant uses natural gas purchased on an interruptible basis as its primary fuel. No. 2 low-sulfur residual oil is used as backup fuel.

Fort Benning has been investigating alternative energy sources since 1978. Recently, the Military Reservation performed a resource recovery feasibility study, which indicated technical and economic merit in using in-plant wastes to produce steam. Currently, Fort Benning operates a landfill on its property for the disposal of its solid wastes. A limited weighing program at the landfill in 1979 indicated that some 60 tons of waste were delivered daily. By 1984, it is anticipated that waste delivered to the landfill will increase to 80 TPD_5, or 57 TPD_7. Based on the favorable results of the feasibility study, $6 million has been appropriated to finance a 100-TPD waste-to-steam facility (average throughput of 57 TPD_7). The steam output from this facility would meet the weekday baseload requirements of the Kelly Mill plant.

In addition, the Military Reservation is investigating the feasibility of using wood from its vast timber holdings (180,000 acres) as a fuel to reduce further its dependence on natural gas and No. 2 oil.

Given the Reservation's plans for a 100-TPD system to recover steam from solid waste, Reservation personnel were questioned about interest in participating in a larger sized joint Columbus/Muscogee-Fort Benning resource recovery facility. Results of these discussions indicate that Fort Benning is interested in exploring the possibility of a joint project that would produce steam and/or electricity. The most viable Fort Benning energy recovery option would cogenerate steam and electricity and tie into the Main Post steam plant, the Reservation's largest plant.* Discussions with Fort Benning personnel indicate that an energy recovery facility located in the Main Post area presents a problem due to possible aesthetic considerations (e.g., truck traffic in the Main Post area, visual impact). However, if these aesthetic issues are resolved satisfactorily, Reservation personnel feel that an energy recovery facility located in the Main Post area would be seriously considered.

Fort Benning personnel indicated that sites of sufficient acreage and satisfactory terrain probably could be secured in areas reasonably close to each of the Reservation's five steam/hot water plants.

During these discussions, Fort Benning indicated a desire to turn over its landfill operation to another entity because of rising costs and increased time demands on management personnel. Given this desire, one possibility is for the Consolidated Government to take over operation (on an expanded basis) of the Fort Benning landfill disposal site, initially for interim disposal, and then for residue and bypassed waste disposal once a resource recovery facility becomes operational.

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* Another option explored was to centrally locate an energy recovery facility to replace two or more steam/hot water plants. This option was rated less attractive and less economically viable due to technifactors and high capital costs associated with installation of new steam lines located some distance from the existing steam line network.

4. TECHNOLOGY ASSESSMENT

In this section, generic descriptions of appropriate technologies are given, followed by preliminary system definitions for an electricity-only system and a cogeneration system. Both systems assume a design capacity of 600-TPD and an average throughput of 490-TPD_7 on an annual basis. These sizing assumptions are based on acquiring 100 percent of the available tonnage as estimated in Section 2 of this report and system availability considerations.

GENERIC SYSTEM DESCRIPTIONS

Appropriate technologies to provide saturated and turbine-quality steam to large customers include mass-burning and coarse RDF-(refuse-derived fuel) fired boilers. Incorporation of turbine-generator sets permits these technologies to provide electrical power as well.

Mass-Burning Systems

Mass-burning resource recovery systems can meet the needs of large steam customers for process or turbine-quality steam. Mass-burning systems are specially designed, field-erected units, which frequently employ proprietary grate and furnace designs. Individual boiler capacities range from 100 to 1,000 TPD. Hundreds of these units have been operating in Europe and Japan beginning in the mid-1960s. Today, there are eight such installations in the United States.

Figure 4.1 presents a simplified diagram of a mass-burning system. As shown in this figure, all of the waste received at the resource recovery facility is fed to the boiler, without any front-end processing or separation. Large systems include concrete pits for storing solid waste so that energy can be produced on days when solid waste is not delivered. The waste is lifted from the

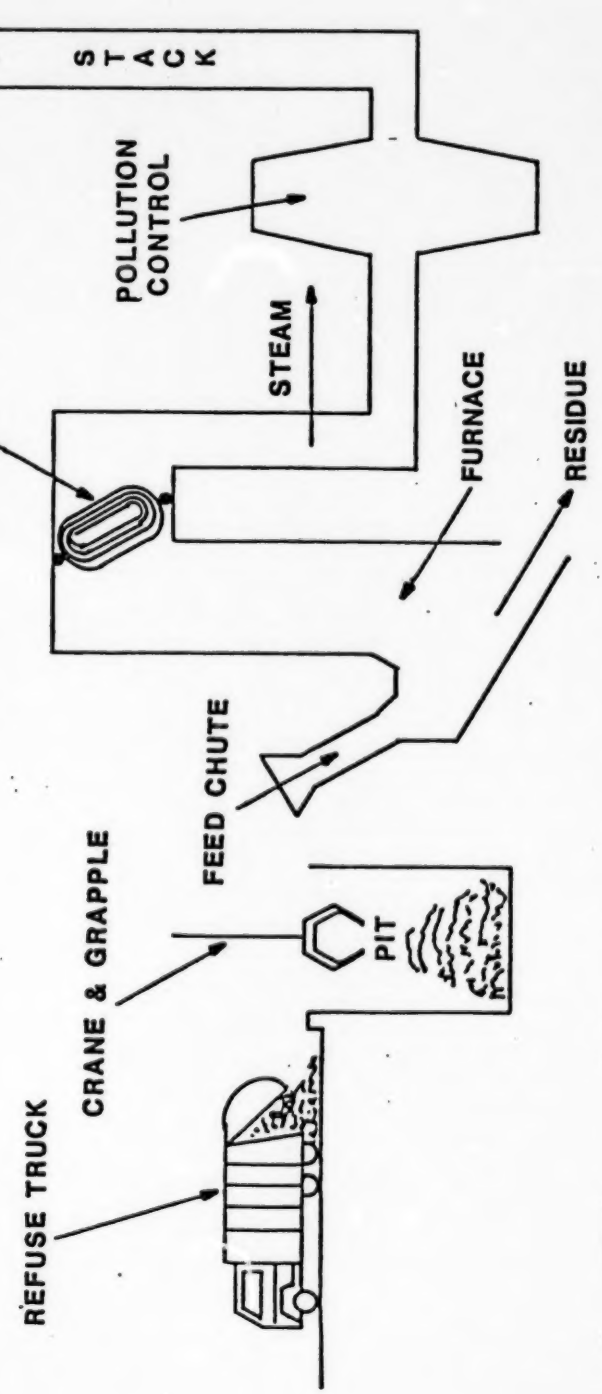


FIGURE 4.1
TYPICAL MASS-BURNING SYSTEM

pit with overhead cranes and grapples and loaded into feed chutes and onto the burning grates. When the waste reaches the grate system, it ignites and burns as it moves down the inclined grates. The air required for combustion is supplied through the bottom of the grates, as well as over the top of the burning waste mass. The gases generated during combustion exit upward through the boiler. The sidewalls of the furnace are frequently lined with water-filled tubes, which capture much of the heat from these gases prior to extraction of the remaining heat in the boiler tube banks following these tubes. The flue gases then enter electrostatic precipitators or baghouses for removal of particulate matter and are discharged to the atmosphere.

Residues from a mass-burning system are usually quenched in water and then passed under a magnet, which recovers magnetic materials for sale to the area's scrap markets. The mass-burning system produces ash that is dewatered to approximately 50-percent moisture, and, if well burned out, is virtually free of combustible residue. This material is used in some European countries as roadbed material, construction material, or landfill cover. Hence, it may be possible to use this ash in the United States at some future time.

The mass-burning furnace is designed and operated to provide steam at the temperature and pressure required by the energy customer.

Prepared Fuel-(Coarse RDF-)Fired Systems

Process or turbine-quality steam requirements of large steam markets can be met by burning fuel prepared from solid waste in a specially designed boiler. Such a system has been operating in Hamilton, Canada, since 1973. For reasons similar to those that caused coal boiler designers to switch from mass-firing to preparing coal prior to combustion (e.g., less energy loss, improved burnout, improved steam quality control, smaller furnace size), interest in this technology has increased. Today, plants using the coarse RDF concept are in startup in Akron, Ohio, and nearing completion of

construction in Buffalo, New York. The fuel preparation and firing systems have been operating in Ames, Iowa, since 1975, as part of a coal-RDF cofiring installation using grate-equipped boilers.

The coarse RDF system is capable of processing large quantitites of solid waste. This process differs from the mass-burning system in that incoming solid waste is processed into a fuel prior to incineration. Figure 4.2 presents a simplified diagram of a coarse RDF system. The waste passes through a "sizing circuit" -- a combination of a mill and a sizing screen. Waste is recirculated through this circuit until all of the material is of uniform size. The coarse RDF particles are passed under a magnet to remove products before incineration, thus enhancing their value in the secondary metals market. The prepared fuel enters a fuel surge bin and a fuel feed system.

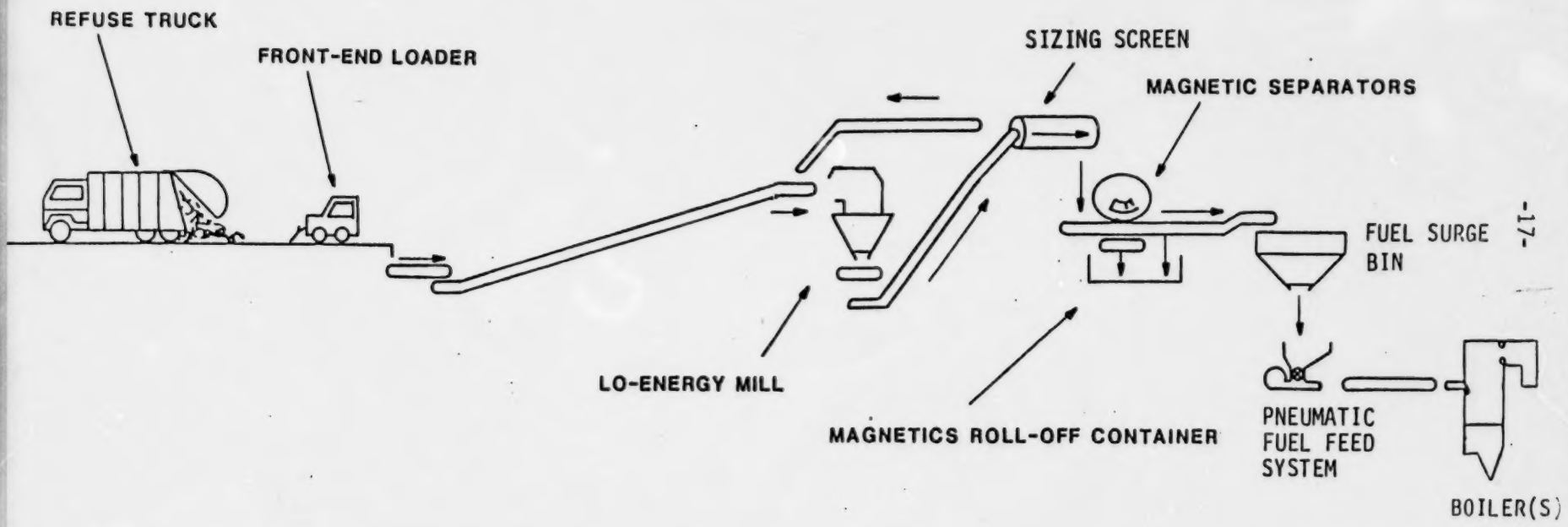
The coarse RDF is then burned in spreader-stoker-equipped boilers to raise steam. In these boilers, unlike mass-burning boilers, the solid waste is projected into the boiler, where much of it burns in suspension, and the remainder falls to a grate system for final combustion.

Combustion air enters with the fuel, under the grate, and above the fuel bed. Because there is relatively little fuel in the boiler at any time, combustion can be closely controlled, and a unit can respond to load changes. Also, improved air and combustion control should enable units of this type to operate with less total air than mass-burning units, thus reducing heat losses from the stack gases and permitting installation of smaller air pollution control equipment.

The spreader-stoker boiler has a higher thermal efficiency than the mass-burning boiler and thus yields more energy per ton of waste input. However, this advantage can be lost easily if too much fuel is lost in fuel preparation. In addition, the initial capital cost for a coarse RDF system is usually lower than that for a mass-burning system of equivalent size because fewer boilers are required. Even with the addition of processing equipment to this system, total capital costs are still below those for a mass-burning system. The disadvantages of the coarse RDF system are the added operating expenses of, and the

FIGURE 4.2

TYPICAL COARSE RDF-FIRED SYSTEM



risks associated with, front-end shredding. The mechanics of handling shredded waste are not yet fully standardized, so that some startup delays could be encountered.

PRELIMINARY SYSTEM DEFINITIONS

As described above, either mass-burning or RDF/dedicated boiler technology could be appropriate. Previous analyses in support of other resource recovery projects have indicated that the economics of these two technology alternatives are comparable. Because of its general simplicity, a mass-burning system was chosen as the reference technology for purposes of analyzing the two system alternatives described below.

Because the Fort Benning Military Reservation is a potential buyer of process steam and/or electricity, two system alternatives were assessed:

- An electricity-only system
- A cogeneration system.

While the Reservation's total steam demand far exceeds the potential steam ouput from a recovery plant with a 490-TPD_7 average throughput, as mentioned in Section 3, the Reservation's five power plants are so geographically dispersed as to preclude technically and economically viable clustering. Each plant is to be considered an individual market. The Reservation's largest steam plant's average hourly steam load is 68,510 pounds of steam (see Table 4.1). A 490-TPD_7 steam-only resource recovery plant would produce some 107,000 pounds of steam per hour, nearly 40,000 pounds per hour greater than the average demand at the largest steam plant. In order to maximize the energy potential of the area's waste, technical options were limited to straight-electricity production or cogeneration.

TABLE 4.1
FORT BENNING MAIN POST PLANT
1980 STEAM PROFILE BY MONTH

MONTH	AVERAGE POUNDS PER HOUR
January	64,560
February	71,900
March	58,280
April	48,560
May	49,810
June	65,020
July	74,200
August	75,390
September	71,470
October	60,530
November	85,870
December	96,530
AVERAGE	68,510

Electricity-Only System

This system (two 300-TPD units) would process an average of 490 TPD_7 of waste to raise steam at 650 psia, 750°F to run a 9-MW condensing turbine.

In defining this system, the following technical assumptions were used:

- The higher heating value (energy content) of the combined wastes from Columbus/Muscogee and Fort Benning Military Reservation is 4,500 Btu per pound.
- System thermal efficiency is 65 percent.
- System configuration is two 300-TPD mass-burning units; each unit has an 83-percent availability, including scheduled maintenance and allowance for forced outage.
- Steam is raised at 600 psia, 750^0F.
- Steam output is approximately 5,700 pounds per ton of waste with 100-percent condensate return at 98^0F.
- Electrical generation steam rate is 12 pounds of steam per kWh.
- System operation is 24 hours per day, 360 days per year.
- Average waste throughput is 490 TPD_7, or 176,400 tons per year.
- Residuals and nonprocessible waste to landfill is 44,100 tons per year.
- A 9-MW condensing turbine is used.

Figure 4.3 depicts the annual plant balance for the electricity-only option described above.

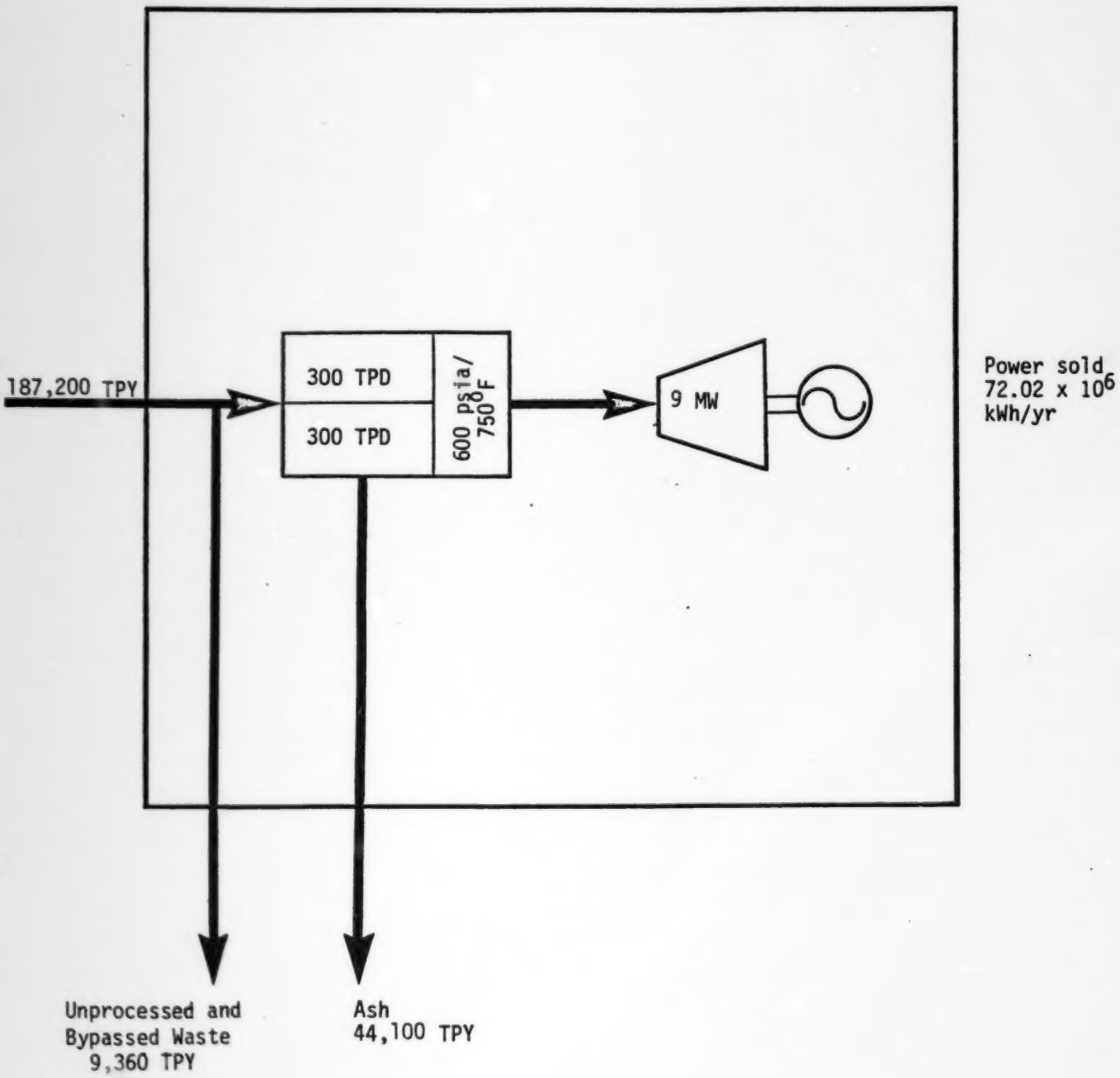
Cogeneration System

This system would also consist of two 300-TPD mass-burners; in this case, however, a 5-MW backpressure turbine would be used. While a backpressure turbine is less efficient than an extraction-condensing turbine, it is also less expensive. It was felt that,

FIGURE 4.3

ANNUAL PLANT BALANCE - 600-TPD MASS-BURNING

ELECTRICITY-ONLY FACILITY



because most of the time the steam raised would be used in process applications rather than to generate electricity, the additional capital cost required to achieve higher efficiency generation was not justifiable.

In defining this system, the following technical assumptions were used:

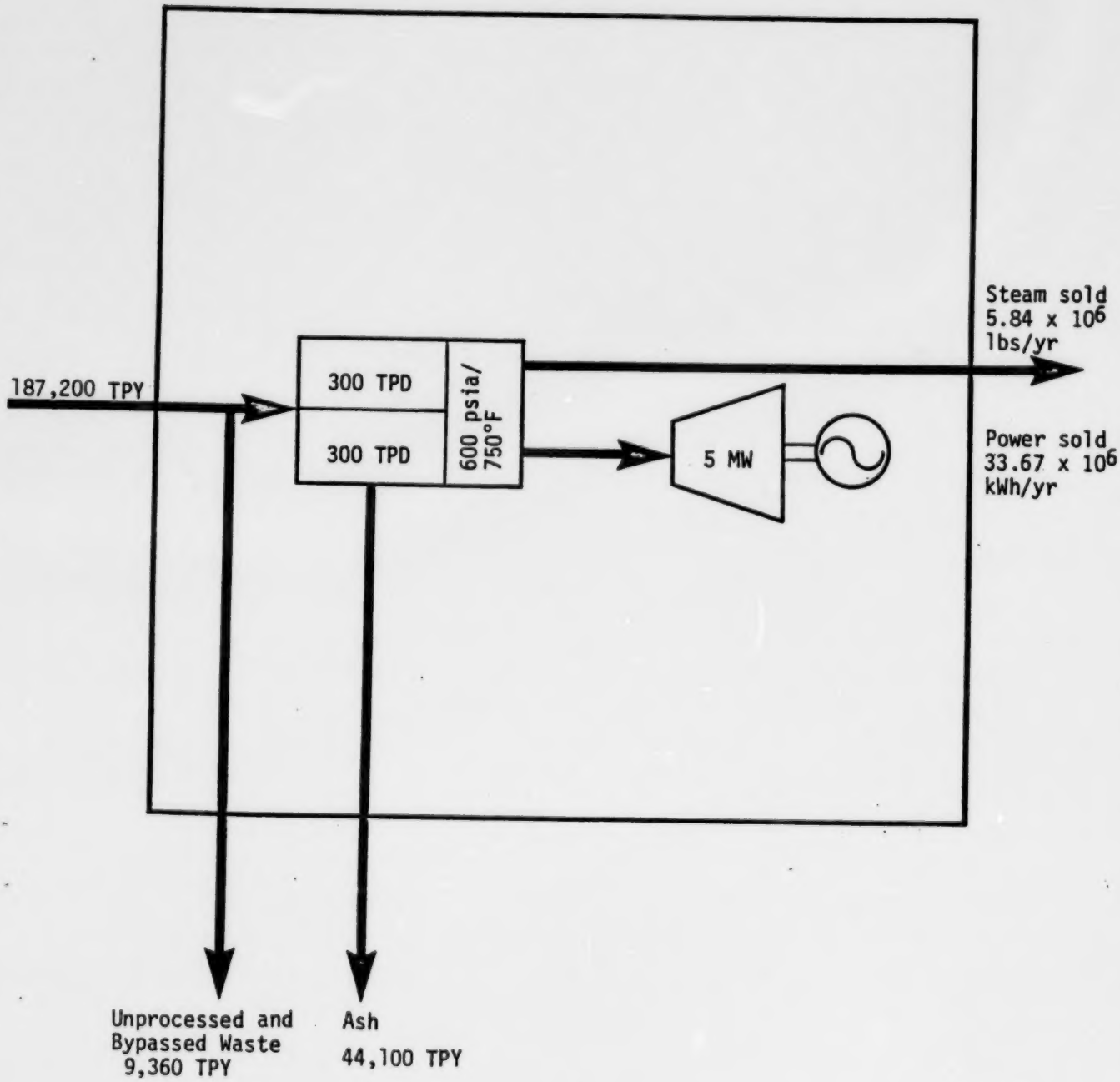
- The higher heating value of the combined wastes from Columbus/Muscogee and Fort Benning Military Reservation is 4,500 Btu per pound.
- System thermal efficiency is 65 percent.
- System configuration is two 300-TPD mass-burning units; each unit has an 83-percent availability, including scheduled maintenance and allowance for forced outages.
- Steam is raised at 600 psia, 750°F.
- Steam output is approximately 5,190 pounds per ton of waste with no condensate return.
- Electrical generation steam rate is 40 pounds of steam per kWh.
- Steam is exhausted at 150 psia, 350°F for process applications.
- System operation is 24 hours per day, 360 days per year.
- Average waste throughput is 490 TPD_7, or 176,400 tons per year.
- Residuals and nonprocessible waste to landfill are 44,100 tons per year.
- A 5-MW backpressure turbine is used.

Figure 4.4 depicts the annual plant balance for the cogeneration option described above.

FIGURE 4.4

ANNUAL PLANT BALANCE - 600-TPD

MASS-BURNING COGENERATION FACILITY



5. PRELIMINARY ECONOMIC ASSESSMENT

The economic feasibility of a resource recovery project may be determined by comparing the projected cost of that option with that of alternative disposal methods. In the case of Columbus/Muscogee, the preferred alternative to resource recovery appears to be the implementation and operation of one or more new landfill disposal facilities.

A preliminary economic assessment was conducted for the two resource recovery system alternatives described in the previous section. A comparison was made of the economics of cogeneration and electricity-only systems and of the economics of these two systems with those of continued primary dependence on landfilling.

In conducting the preliminary economic analysis, it was found that the bond issue requirements, and, hence, the cost of a resource recovery system vary significantly, depending on the financing method used. To take these variations into account, cost projections were developed under two different financing methods: 100-percent industrial revenue bond (IRB) financing and 75-percent IRB/25-percent equity financing.

To date, IRBs have been the principal instrument used for financing resource recovery projects. However, because of the tax benefits it affords to the investor, equity investment in a resource recovery project is becoming more common and was therefore included in the comparative economic analysis.

The cogeneration system was assessed under both financing approaches. The electricity-only system was first assessed under the more optimistic financing approach (75-percent IRB/25-percent equity). Because the estimated economics did not appear favorable under combined IRB/equity financing, this system was not assessed assuming 100-percent IRB financing.

Even assuming 25-percent equity participation, the preliminary economic analysis indicates that an electricity-only facility does not appear to be an economically competitive option. The 1984 net disposal cost is projected at around $27.00 per ton of waste, and is estimated to be around $30.00 per ton in 1989.

A cogeneration facility, on the other hand, appears to have promising economics under both financing approaches. Under 100-percent IRB financing, the 1984 net disposal cost would be around $16.00 per ton, with an estimated cost of $9.00 in 1989. Under the combined IRB/equity financing, the respective costs are projected at $9.00 and $2.00 per ton.

The remainder of this section summarizes the methodology and the assumptions used, as well as the findings and conclusions.

METHODOLOGY

To be considered economically feasible, a resource recovery project should offer the Consolidated Government and Fort Benning a net solid waste disposal cost that is competitive with the cost of continued primary reliance on landfilling. The net solid waste disposal cost is determined by subtracting project energy revenues from the capital and operating and maintenance costs associated with the resource recovery facility and the capital and operating and maintenance costs of a backup landfill for residues, unprocessibles, and wastes that must bypass the facility.

To determine the economic feasibility of the two alternatives, the net disposal cost of each alternative was projected for 1984 and 1989, the assumed first and sixth years of facility operation. The year 1984 was selected as the first year of facility operation to reflect the lead time for design, construction, and startup of the resource recovery facility. Although life-cycle costing would have been an appropriate method of economic evaluation, the difficulty of projecting costs and revenues over the life of a facility (more than 20 years) limited the projections to 1989.

The assumptions used in developing the economic projections and the derivation of the major elements of the cost projections are summarized below.

Projected System Costs

The 1981 capital costs of each option evaluated were developed from engineering estimates and recent bids submitted by full-service

vendors for comparably sized resource recovery systems; these costs were then projected to 1983 (assumed to be the midpoint of construction) at an annual compounded rate of 10 percent for both the IRB and IRB/equity financing approaches. For both financing methods, energy and disposal fee revenues are the only source of funds for payment of principal and interest to bondholders. Revenue bonds offer tax-exempt interest at a rate assumed to be 11 percent. For IRB/equity financing, the 25-percent equity contribution enables reductions in the debt service reserve and capitalized interest accounts and reduces the total bond issue by approximately $1.45 for each dollar of equity invested.

Projected Energy Revenues

In projecting the energy revenues for each alternative evaluated, the following assumptions were made:

- The resource recovery facility becomes operational in 1984.
- Capital costs escalate at an annual rate of 10 percent per year until 1982, the midpoint of construction, at an annual rate of 10 percent; operating and maintenance costs escalate at 10 percent per year until 1989.
- Financing terms are: 22 years at 11 percent interest for IRB and IRB/equity financing approaches.
- Steam energy revenues are predicated upon the fuel (natural gas) value of 125-psia steam at an assumed boiler efficiency of 85 percent with no condensate return. Natural gas is assumed to be deregulated by 1984 and priced at parity with No. 6 fuel oil. Annual escalation in fuel prices is 10 percent,* hence steam revenues increase at the same rate.
- Electricity revenues are based on projected average 1984 electricity costs of 4.5¢/kWh. Annual escalation is assumed to be 10 percent.

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* To the extent that energy prices increase at a rate in excess of the general inflation rate, in this case assumed to be 10 percent per year, revenues from energy sales will be greater than projected.

Projected Backup Landfill Costs

To fully reflect the costs of disposal under resource recovery, consideration has to be given to the ultimate disposal of unprocessible wastes, bypassed wastes, and residuals from combustion. For purposes of this preliminary analysis, it was assumed that the average per-ton cost of landfilling this volume of waste in an environmentally complying disposal facility would be $14.00 in 1984, with a 10-percent annual escalation.

It was assumed that unprocessibles represent 5 percent of the total waste available, all processible materials delivered to the facility are accommodated, and residuals represent 25 percent of the input tonnage. These assumptions are based upon the data provided by the weighing program at the Wilson Camp landfill.

Projected Costs of Continued Primary Reliance on Landfilling

Based on data provided by Fort Benning personnel and assuming a 10-percent annual increase in operating and maintenance costs, the disposal costs to the Reservation are estimated at $15.00 per ton in 1984 and $20.00 per ton in 1989.

While the 1980 per-ton cost of disposal to Columbus at the Wilson Camp landfill is estimated at around $6.00, it is likely that this cost will increase substantially should Columbus elect to acquire and operate one or more new landfill disposal sites that are in full compliance with environmental regulations. Should Columbus acquire a new landfill, a 1984 per-ton cost in the $10 to $15 range is not unrealistic. Assuming a 10-percent annual increase in operating and maintenance costs, the 1989 per-ton cost of landfill disposal would range from $15 to $20 per ton.

FINDINGS/CONCLUSIONS

The following table presents the projected 1984 and 1989 net disposal costs for continued landfilling, a 600-TPD cogeneration resource

recovery facility, and a 600-TPD electricity-only resource recovery facility.

OPTION	FINANCING METHOD	1984 COST ($ per ton)	1989 COST ($ per ton)
Landfilling	-	$10 - $15	$15 - $20
Cogeneration	100% IRB	16	9
Cogeneration	75% IRB/25% Equity	9	2
Electricity-Only	75% IRB/25% Equity	27	30

Tables 5.1 and 5.2 present the estimated financing requirements for the cogeneration facility and the electricity-only facility, respectively.

Tables 5.3 and 5.4 give the projected economics for the cogeneration facility under 100-percent IRB financing and 75-percent IRB/25-percent equity financing, respectively. Table 5.5 gives the same information for the electricity-only facility assuming combined IRB/Equity financing. It should be noted that waste-derived energy was assumed to be sold at its market value (i.e., on a nondiscounted basis). Many resource recovery projects to date have offered revenue sharing or energy price discounts to encourage the prospective energy customer to participate in the project. Even assuming a 10-percent discount on steam to Fort Benning, the projected cost of disposal under resource recovery appears considerably less expensive than the option of acquiring and operating one or more new landfill disposal sites.

TABLE 5.1

FINANCING REQUIREMENTS FOR 600-TPD

MASS-BURNING COGENERATION FACILITY*

(1982 dollars)

COST ELEMENTS	FINANCING METHOD	
	IRB ($000)	25% EQUITY/IRB ($000)
A. Capital Cost	$33,660	$33,660
B. Engineering/Legal	500	500
Less Equity Contribution	-	(8,540)
SUBTOTAL	34,160	25,620
C. Capitalized Interest	4,065	1,310
D. Allowance for Startup	830	830
E. Debt Service Reserve Fund	5,480	3,980
F. Bond Financing	1,350	980
TOTAL BOND ISSUE	45,880	32,720
TOTAL FINANCING REQUIREMENTS (including Equity)	$45,880	$41,260

* Costs are projected to 1982 $ as 1982 would be the beginning of the design/construction phase; hence the bond would be issued in 1982.

TABLE 5.2

FINANCING REQUIREMENTS FOR 600-TPD
MASS-BURNING ELECTRICITY-ONLY FACILITY*
(75% IRB/25% Equity Financing)

COST ELEMENTS	$000
A. Capital Cost	$39,020
B. Engineering/Legal	500
Less Equity Contribution	(9,800)
SUBTOTAL	29,720
C. Capitalized Interest	1,510
D. Allowance for Startup	830
E. Debt Service Reserve	4,590
F. Bond Financing	1,130
TOTAL BOND ISSUE	37,780
TOTAL FINANCING REQUIREMENTS (incl. Equity)	$47,580

* Costs are projected to 1982 $ as 1982 would be the beginning of the design/construction phase; hence the bond would be issued in 1982.

TABLE 5.3
PROJECTED ECONOMICS FOR 600-TPD
MASS-BURNING COGENERATION FACILITY
(100% IRB Financing)

ANNUAL SOLID WASTE THROUGHPUT (tons)	176,400
ANNUAL ENERGY SALES (pounds of steam)	584,161,000
(kWh electricity)	33,667,000

EXPENSE ITEM ($/ton)	OPERATING YEAR	
	1 (1984)	6 (1989)
Debt Service	$ 31.10	$ 31.10
O&M	16.00	25.80
Residual Disposal	4.00	6.40
Operator's Fee	3.00	4.80
SUBTOTAL	54.10	68.10
REVENUES ($/ton)		
Steam	$ 25.30*	$ 40.80*
Electricity	8.60*	13.80
Debt Service Reserve Earnings	4.00	4.00
SUBTOTAL	38.00	58.70
REQUIRED TIP FEE* ($/ton)	$ 16.10	$ 9.40

* Energy revenues do not reflect any discount to the prospective energy customer. The extent to which waste-derived energy is discounted will result in an increased tip fee (i.e., per-ton disposal cost). For instance, a 10-percent discount in the price of steam will increase projected 1984 net disposal costs by approximately $2.50/ton, and 1989 costs by $4.80/ton.

TABLE 5.4
PROJECTED ECONOMICS FOR 600-TPD
MASS-BURNING COGENERATION FACILITY
(75% IRB/25% Equity Financing)

ANNUAL SOLID WASTE THROUGHPUT (tons)	176,400
ANNUAL ENERGY SALES (pounds of steam)	584,161,000
(kWh electricity)	33,667,000

EXPENSE ITEM ($/ton)	OPERATING YEAR	
	1 (1984)	6 (1989)
Debt Service	$ 22.60	$ 22.60
O&M	16.00	25.80
Residual Disposal	4.00	6.40
Operator's Fee	3.00	4.80
SUBTOTAL	$ 45.60	$ 59.60
REVENUES ($/ton)		
Steam	$ 25.30*	$ 40.80*
Electricity	8.60*	13.80*
Debt Service Reserve Earnings	2.90	2.90
	$ 38.90	$ 57.60
REQUIRED TIP FEE ($/ton)	$ 8.70	$ 2.00

* Energy revenues do not reflect any discount to the prospective energy customer. The extent to which waste-derived energy is discounted will result in an increased required tip fee (i.e., per-ton disposal cost). For instance, a 10-percent discount in the price of steam will increase projected 1984 net disposal costs by approximately $2.50/ton, and 1989 costs by $4.80/ton.

TABLE 5.5

PROJECTED ECONOMICS FOR 600-TPD
MASS-BURNING ELECTRICITY-ONLY FACILITY
(75% IRB/25% Equity Financing)

ANNUAL SOLID WASTE THROUGHPUT (tons)	176,400
ANNUAL ENERGY SALES (kWh electricity)	72,019,000

EXPENSE ITEM ($/ton)	OPERATING YEAR	
	1 (1984)	6 (1989)
Debt Service	$ 26.00	$ 26.00
O&M	16.00	25.80
Residual Disposal	4.00	6.40
Operator's Fee	3.00	4.80
SUBTOTAL	49.00	63.00
REVENUES ($/ton)		
Electricity	$ 18.40*	$ 29.60*
Debt Service Reserve Earnings	3.40	3.40
SUBTOTAL	21.80	33.00
REQUIRED TIP FEE ($/ton)	$ 27.20	$ 30.00

* Energy revenues do not reflect any discount to the prospective energy customer. The extent to which waste-derived energy is discounted will result in an increased required tip fee (i.e., per-ton disposal cost).

6. PRELIMINARY ENVIRONMENTAL ASSESSMENT

This section addresses environmental requirements for a 490-TPD_7 cogeneration resource recovery facility. Construction and operation of such a facility will be subject to federal, state, and local environmental regulations. Table 6.1 is a list of the permits that may be required. The remainder of this section summarizes the results of the preliminary environmental assessment.

AIR QUALITY

Classification of the facility will influence air permitting requirements and schedules. The facility will either be classified as an incinerator (primary function to burn and reduce the volume of refuse) or as fuel-burning equipment (primary function to burn fuel to produce thermal energy). A resource recovery facility combines these two functions; hence its status, until actually classified, is uncertain. While it is anticipated that the Georgia Department of Environmental Protection (DEP) will classify such a facility as an incinerator, because of this uncertainty, the air review that follows considers the implications of both classifications.

Potential air impacts were reviewed for conformance with:

1. Georgia emission limitations
2. Georgia/federal new source review criteria
3. New source performance standards (NSPS)
4. Ambient air quality standards (AAQS).

The most stringent of these applicable limitations will govern the stack emissions permitted.

Georgia Emission Limitations

Applicable Georgia emission limitations are summarized in Table 6.2 Of prime importance will be particulate emissions.

TABLE 6.1
SUMMARY OF REQUIRED PERMITS

EMISSIONS	PERMIT	PERMITTING AGENCY	AGENCY REVIEW TIME
Air	Prevention of Significant Deterioration (PSD) Permit	Georgia DEP	3-6 months
Water Use	Water Withdrawal Permit (if more than 100,000 gal/month of water withdrawn from a natural water supply)	Georgia DEP	Unknown
Wastewater Discharge	Sewer Use Permit (not currently required but possibly will be required in future if discharge to the City sewer system)	Columbus Water Works	Not established
	National Pollutant Discharge Elimination System (NPDES) Permit (if discharge to a natural waterbody)	Georgia DEP	Unknown
Solid Waste	Solid Waste Handling Permit	Georgia DEP	Unknown

TABLE 6.2

APPLICABLE GEORGIA AIR EMISSIONS LIMITATIONS

POLLUTANT	FUEL-BURNING EQUIPMENT (less than 250 million Btu/hour)	INCINERATOR (capable of charging more than 50 TPD)
Particulates	Emissions = $0.5(\frac{10}{R})^{.5}$ lb/million Btu where R = heat input in million Btu/hr	Emissions = 0.8 grains/scf @ 12% CO_2
	Opacity Limit is 20%	Opacity Limit is 20%
NO_x	Not applicable	Function of stack height
SO_2	Function of stack height	Function of stack height; or for units less than 100 million Btu/hour, the fuel is limited to 2.5% sulfur by weight; or for units greater than 100 million Btu/hour, the fuel is limited ty 3.0% sulfur by weight.
Fugitive Particulate Emissions	All reasonable precautions must be taken to prevent particulate matter from becoming airborne as a result of material transport, handling, or storage.	

The particulate emission limitation for an incinerator capable of charging more than 50 TPD of refuse is 0.08 grains per standard cubic foot at 12-percent CO_2.

The particulate emission limitations for fuel-burning equipment with a heat input of less than 250-million-Btu per hour is a function of the actual heat input of the fuel-burning equipment. If, for example, the facility processes 500 TPD of refuse and the refuse has a heating value of 4,500 Btu per pound, then the heat input of the facility will be 187.5 million Btu per hour. The corresponding particulate emission limitation will be 0.12 pounds per million Btu, or approximately 0.05 grains per standard cubic foot at 12-percent CO_2. In this case, the fuel-burning equipment emission limitation would be more restrictive than the incinerator limitation

In addition to the stack emission limitations for particulates, the state requires that all reasonable efforts be made to control fugitive dust. This requirement can be significant for ash disposal at a landfill.

New Source Review Criteria

Columbus is designated as an attainment area for all criteria pollutants because existing ambient air quality concentrations are within federal and state AAQS. Federal new source review criteria stipulate that a new source is "major" in an attainment area if potential emissions (controlled) exceed 250 tons per year. A "major" source must obtain a PSD permit prior to commencing construction. If the facility is classified as an incinerator and is capable of charging more than 250 TPD of refuse, the emissions trigger level for PSD review is 100 tons per year.

The proposed facility will most likely be a "major" source requiring a PSD permit regardless of facility classification. The PSD permit requires BACT (Best Available Control Technology) review and an air quality analysis (modeling and perhaps monitoring). BACT

will require particulate emissions control either in the form of a baghouse or an electrostatic precipitator. The air quality analysis must demonstrate compliance with federal and state AAQS and with allowable PSD increment consumption.

A single air permit will be issued by the state to cover pollutants subject to PSD review, as well as those that are not covered by PSD review. Georgia has PSD authority; hence, federal review will not be required.

New Source Performance Standards

If classified as fuel-burning equipment, it is possible that a resource recovery facility could fall into: (1) the Steam Electric Industry category if steam were used to generate electricity for sale and the heat input of the unit were greater than 250 million Btu per hour; or (2) the Fossil Fuel Boiler category if the heat input of the unit were greater than 250 million Btu per hour. The facility as described in this report would have a heat input of less than 250 million Btu per hour; hence, as fuel-burning equipment, such a facility would not be subject to federal NSPS.

For incinerators, NSPS exist for particulate emissions (0.08 grains per standard cubic foot at 12-percent CO_2) if the incinerator processes 50 TPD or more of refuse. This limitation would likely apply to the project as preliminarily defined in this study. In this case, the NSPS particulate emission limitation is the same as the Georgia emission limitation for an incinerator.

Ambient Air Quality Standards

Emissions from the facility must not cause violations of federal and state AAQS. Georgia has adopted the national standards for ambient air quality and increment consumption with the exception that the 24-hour particulate concentrations are limited to 150 $\mu gm/m^3$, which is the secondary national AAQS.

WATER QUALITY

The facility can obtain water for in-plant use from either City water lines or natural surface or groundwater supplies. If water is obtained from the City, it will be necessary to discuss water requirements with the Columbus Water Works to ascertain whether enough water is available. If water in excess of 100,000 gallons per month is extracted from a natural water supply, a water withdrawal permit must be obtained from the Georgia DEP prior to such withdrawal.

Process wastewater discharges include floor and tipping floor washdown, truck and equipment washdown, sanitary flow, boiler blowdown, and ash quench water. Nonprocess discharges include stormwater runoff from paved areas and roof drains.

Either category of discharge could be discharged to the City sewer system or a natural waterbody.

If the effluent is discharged to the Columbus sewer system, it must meet the requirements of the City's Sewer Use Resolution Ordinance. In addition, the facility's effluent must not interfere with the operation of the City's sewage treatment plant or cause that plant to violate its discharge permit. Pretreatment may be required prior to discharge to the sewer line. While a discharge permit is not currently required, one will likely be required in the future (one year or more from now) by the Columbus Water Works prior to connection to the City sewer system.

If the process wastewater and stormwater runoff are discharged to a natural waterbody, a NPDES permit will be required from the DEP prior to facility construction. Effluent limitations are a function of the classification of the waterbody to which the facility is discharging.

SOLID WASTE DISPOSAL

Solid wastes produced by resource recovery facilities include bypassed wastes (e.g., noncombustibles, oversized bulky wastes) and residual products of combustion (i.e., bottom ash or fly ash collected in an air pollution control system).

The most significant question regarding the disposal of solid waste is whether the combustion residuals constitute a hazardous waste as defined by Resource Conservation and Recovery Act (RCRA) regulations. If the ash is found to be hazardous, such materials would have to be disposed of in an approved hazardous wastes disposal facility -- none of which currently exists in Georgia.

For nonhazardous wastes, the simplest means of disposal would be the use of existing sanitary landfills. The primary issue for these wastes relates to location relative to the resource recovery facility and available capacity.

Resource recovery facilities that accept only household, apartment, and hotel waste are automatically exempted from the RCRA regulations. In this case, the owner or operator is not required to determine if ash generated by the facility is hazardous, because the facility is accepting only wastes specifically identified as nonhazardous.

Wastes from small businesses, offices, and industries, are <u>not</u> exempt; hence, the residues from processing these wastes can be subject to regulation under RCRA.

There are no resource recovery projects in place in Georgia; discussions with the Land Protection Branch of the DEP reveal that no permit applications have been filed as yet for review for a resource recovery project. Current solid waste regulations in Georgia stipulate that a resource recovery facility must obtain a solid waste handling permit prior to construction. All bypassed and residual material must be disposed in an approved sanitary landfill. This requires that the solid waste be covered by fill on a daily basis.

The Land Protection Branch has stated, however, that the sanitary landfill requirement was established for past incinerator technology and that new regulations will likely be adopted for resource recovery facilities. As mentioned previously, dust control measures will be necessary at the disposal area.

OTHER ENVIRONMENTAL CONSIDERATIONS

Consideration must be given to such potential impacts as odor, noise, traffic, historic district, wild or scenic rivers, and endangered species. While these activities do not require permits, their potential impacts should be mitigated by proper selection of the site for the facility and by proper design.

EIS (ENVIRONMENTAL IMPACT STATEMENT) REQUIREMENT

It is not anticipated that the state will require an EIS for the proposed facility unless state funds are used to finance the project.

A federal EIS will not be required unless dredging and/or filling for a navigable waterway is necessary. In such a case, a Corps of Engineers' dredge and fill permit is also required.

7. LEGAL/INSTITUTIONAL ISSUES AND NEXT STEPS

The results of this preliminary feasibility study indicate that resource recovery can be a cost-effective solid waste management option for the Columbus/Muscogee County area. In response to these encouraging findings the Columbus Consolidated Government has taken the first step toward project implementation by creating the Columbus Resource Recovery Development Authority (Authority) as authorized under Ga. Code Ann. Chapter 69-15A. In activating the Authority, the Columbus Council has appointed as directors, the current members of the Columbus Water Board.

The remainder of this chapter discusses the implications of such an authority; immediate next steps to be taken; and the major technical, environmental, legal/institutional and financial issues related to project implementation.

COLUMBUS RESOURCE RECOVERY DEVELOPMENT AUTHORITY

The Columbus Resource Recovery Development Authority under law has many powers and considerable flexibility in implementing an energy recovery project. Among the salient features of the Authority are the following:

- The power to enter into binding long-term contracts (up to 50 years) with the City and County for the disposal of solid waste and for a similar period of time with private utilities for the operation of a recovery facility.
- The power to enter into negotiated (contrasted with comparatively bid) long-term contracts for the sale of recovered energy and materials.
- The power to procure a recovery facility in any manner which is deemed by it to fulfill the public purpose for which it was created, including joint venture relationship with private enterprise.
- The power to issue tax-exempt revenue bonds for the design and construction of a recovery facility, to pledge revenues received as well as assets of the

Authority to cover payment of principal and interest on such revenue bonds, and to do such other necessary acts as may be required to provide the necessary security for the bonds issued by the Authority. The Authority, however, has no power of taxation, and revenue bonds issued by it do not affect the credit rating and debt ceiling of the participating units of government.

- The authority to borrow money for corporate purposes and to receive loans, gifts and grants, and to issue notes in anticipation of the issuance of revenue bonds for a project. However, Chapter 69-15A provides that such obligations of the Authority other than revenue bonds "shall be payable from the general funds of the Authority and shall not be a charge against any special fund allocated to the payment of revenue bonds..."

Implementation of an energy recovery project is a serious endeavor. Implementation requires commitment, leadership, and resources--both personnel and monetary. Creation of the Authority represents the commitment. The Authority must provide the leadership and assemble resources necessary to successfully implement a project. However, prior to mustering the necessary resources and committing them to a successful implementation, the Authority needs to verify that Fort Benning is an interested and committed purchaser of steam and electricity from a waste-to-energy facility.

During the preparation of this report the Consolidated Government submitted a request to the Commanding General of Fort Benning for a meeting to determine Fort Benning's commitment to being an energy buyer of steam and electricity. The key issues which must be mutually agreed to at that meeting in order for the Consolidated Government to proceed with project implementation are:

- Willingness of the Commanding General to enter into a long-term purchase agreement (at least 20 years) on a take-or-pay basis for steam and electricity. The term "take or pay" means that Fort Benning will take all steam and electricity produced at the energy recovery facility, and if it is unable to accept such energy output, the Base will pay as if it had received such output.

- Determination of the price at which steam and electricity will be pegged over the life of an energy sales agreement. With respect to steam this means that the price per thousand pounds paid for steam will be pegged

to changes in the price of natural gas, or the specific weighted average price of natural gas and No. 6 oil over the life of the contract.

- Determination of whether or not a discount on the price of steam and on the price of electricity will be received, and if so, the acceptable level of discount.

  (Note: For other military bases as prospective energy purchasers, as little as a 5-percent discount has been required on the purchase price of steam.)

IMMEDIATE NEXT STEPS

If the response from the meeting with the Commanding General is favorable, then the Authority will need to undertake the following tasks including resolution of associated issues.

1. Negotiations with Fort Benning

The following issues will have to be resolved in order to reach a final agreement with the Reservation:

- Agreement as to which of the five power plant's output will be displaced by the output from a waste-to-energy facility. This study has indicated that the Main Post steam plant offers the most favorable opportunity, but due to potential siting issues will require special design considerations.

- Identification of the specific site that will be made available for the energy recovery facility including the right-of-way for a steam line and the designated point of interconnection to the electric grid of the Base.

- Determination that the power plant being displaced will be available to provide backup steam output during periods of scheduled and unscheduled downtime at the energy recovery facility. If not, will Fort Benning be willing to accept interruptible steam delivery or will they require a non-interruptible supply?

- Agreement that electricity can be supplied on an interruptible basis, since electricity output from the energy recovery facility represents only a portion of the electricity consumed by the Base.

- Agreement that the Base will supply the energy recovery facility with treated boiler feed water from the Base power plant being displaced, as well as agreement as to

the price to be paid for treated water.

(Note: The cost of water supplied by the Base could be incorporated into the net price of steam paid by Fort Benning.)

- Determination as to how boiler blowdown, washdown, and sanitary effluents will be treated before final discharge.

- Agreement that the landfill at Fort Benning can be closed down and that all residuals and bypassed processible wastes from the energy recovery facility as well as nonprocessible solid wastes generated by the Base will be disposed of by the Authority. In this connection, the savings to the Base in landfill cost should be credited to the account of the Authority. Such a credit could be achieved via the price paid by Fort Benning for steam and electricity.

- Agreement whether or not processible solid waste generated at Fort Benning will have priority for acceptance at the energy recovery facility.

- Agreement that an experienced private operator under long-term contract to the Authority will be acceptable to Fort Benning for the operation of the energy recovery facility. Related to this issue is the need to establish that Fort Benning does not insist upon its operating of the energy recovery facility.

- Determination whether or not Fort Benning would permit an energy recovery facility to be located on its property if owned and operated by private enterprise.

  (Note: This determination is important to decisions by the Authority on procurement and financing.)

2. Verification of Waste Characteristics

Only limited data on the tonnage actually generated within the jurisdiction of the Consolidated Government was collected during the course of this prefeasibility study. Limited weigh data from 1979 were available from Fort Benning. Greater knowledge as to the tonnage of processible solid waste generated in the City, County, and Fort Benning is essential for two reasons. First, the City, County, Fort Benning and private haulers will have to contract on a long-term basis with the Columbus Resource Recovery Development Authority for delivery of processible solid waste on a monthly or annual basis. Because the Authority has to depend upon a disposal fee from those delivering waste to its energy recovery facility

to cover part of the total annual cost (debt service plus O & M costs) of the facility, it can be expected that it will want a guaranteed commitment for delivery of a specified tonnage from each waste supplier. Additionally, the Authority will want such a guaranteed delivery because revenues from the sale of steam and electricity will be directly related to the tonnage of waste processed at its facility.

Second, appropriate determination of the capacity of the system, including capacity of individual combustion units and waste storage requirements, cannot be reasonably established without better tonnage data than currently exists. The absence of better data may well result in the plant being unnecessarily oversized, hence costing more than otherwise might be the case. Lack of sufficient tonnage data will also preclude the Authority from determining with confidence that it can permit Fort Benning to shut down one or more of its power plants. Lack of such determination could result in a lower energy price received for steam and/or electricity sold by the Authority.

In addition to better tonnage data, composition of the solid waste also needs to be established. Knowledge of waste composition is important because the heat content of the waste directly affects the quantity of steam that can be raised per ton of waste burned, as well as design and performance considerations of the combustion system. The Btu content of municipal solid waste can range from as low as 3,600 Btu per pound to as high as 6,500 Btu per pound of processible waste. Such a broad range is too great for establishing the design and performance of a system. In addition, knowledge of waste composition is important, since the nonprocessible proportion of the waste stream ranges from a low of 2 percent to a high of 20 percent. The quantity of processible waste affects both system sizing and energy output.

As a result of the above considerations, the Authority, or the Consolidated Government on behalf of the Authority, needs to undertake the following tasks in order to establish waste characteristics:

- Institute an ongoing weighing program similar to that done for the prefeasibility study in order to establish daily and monthly tonnages generated within the Consolidated Government jurisdiction, including Fort Benning.

- Undertake a one-week statistically valid waste sampling and laboratory analysis program on a quarterly basis to establish the variability in the higher heating value, moisture and ash content of the processible waste generated in the area.

- Undertake concurrent with the sampling program a composition program to determine the nonprocessible and processible fractions of the waste stream; for the processible fraction determines the combustible and noncombustible components. This latter analysis should be used in checking the results of the laboratory analysis of waste samples.

3. Waste Acquisition Strategy and Implementation

Currently Columbus and Muscogee County collect about 46 percent of the processible tonnage generated in the area. Fort Benning is estimated to account for approximately 9 percent of the total waste supply, while the remaining 45 percent, or 222 TPD_7, is collected by private haulers under individual contract with homeowners and commercial industrial establishments. To ensure that all processible waste is available to the proposed energy recovery facility, the Authority has two major options open to it. One option is to enter into a long-term contract with the Consolidated Government for delivery of all processible solid waste generated within its jurisdiction on a put-or-pay basis, and into a separate long-term, put-or-pay contract with Fort Benning for delivery of its processible waste to the energy recovery facility. This approach will obligate the Consolidated Government to guarantee delivery of a minimum monthly and annual tonnage, including that collected by private haulers or transported by individuals (residential or business and industrial establishments). In order to make such guarantee, it will be essential that the Consolidated Government have the power to direct where private haulers and individuals dispose of their solid waste. One way for the Consolidated Government to achieve such control over private haulers is for it to establish collection districts (with the assistance of the private haulers) and to issue franchises to individual haulers for each district to act as agents of the Consolidated Government in the collection and disposal of solid waste. Private haulers as agents of the Consolidated Government can be directed by it as to where they should dispose of the solid waste they collect. Existing ordinances should be reviewed by the City and County to establish that

such local legislation contains the power to specify the specific disposal facility that individuals must use to dispose of their solid waste. If the existing ordinances do not provide for such power, then they will need to be amended to provide for such power to direct where solid waste may be disposed.

The second option would be for the Authority to negotiate contracts on a long-term, put-or-pay basis with: a) the Consolidated Government for the solid waste which it collects; b) Fort Benning for the waste it generates; and c) individual private haulers for the solid waste each collects. Such a contractual approach is probably preferable to franchising collection districts and legislating the power to mandate where waste may be disposed. However, a difficulty with this approach pertains to long-term agreements with private haulers. Private collection is a price-sensitive, highly competitive business. As a result, it probably will be impossible for individual private haulers to guarantee delivery of a specified monthly and/or annual tonnage on a long-term basis. At best, individual companies can be expected to realistically contract to deliver all the waste they collect for as long as they remain in business. As long as those haulers accounting for, say, 90 percent of the waste privately collected are under contract, such an approach to acquiring waste ought not present a problem with respect to issuing revenue bonds for financing construction of the proposed energy recovery facility. However, members of the Authority and elected officials of the Consolidated Government should recognize that the investment banking firm underwriting the bond issue may want local waste flow control legislation, such as franchise collection districts, as a backup to contracts with private haulers in order to make the marketing of revenue bonds easier and, from his perspective, more attractive.

MAJOR ISSUES

The following section discusses the major legal/institutional, technical, environmental and financial issues which must be addressed in project implementation.

1. Legality of Electricity Sales to Fort Benning

Currently Fort Benning meets its electricity requirements through the purchase of electricity from Georgia Power. Depending upon the terms of the utility's franchise in Muscogee County, it may be illegal for the Authority to produce electricity for sale to Fort Benning. It is essential that the Authority establish at an early date whether or not it has the right to sell electricity to Fort Benning or any other user.

If it is determined that it does not have this right, a potential solution would be to lease the turbine-generator set to the Base for a nominal sum of money and sell only steam. If such an arrangement is made, it should be recognized that it may be necessary to work out with Fort Benning a two-tier price arrangement for steam, to reflect its differential value for producing electricity and for meeting process and space conditioning requirements.

Another possible solution would be to sell electricity to Georgia Power on an avoided cost basis, as provided under the Public Utility Regulatory Policy Act of 1978. In order to avoid potentially costly expenses associated with interconnecting with Georgia Power's grid, an arrangement should be worked out whereby interconnection is made with Fort Benning's grid, but the electricity delivered to Fort Benning is treated as if it were sold directly to Georgia Power.

2. System Definition and Performance Specifications

Based upon the results of negotiations with Fort Benning and results from the waste characterization program and decisions about the sale of electricity, a final system definition should be undertaken. Final system definition will involve: 1) determination of installed processing capacity required and number of combustion units required; 2) waste storage capacity and delineation of waste receiving and handling requirements; 3) trade-off analysis between processing capacity and storage as these two factors relate to plant reliability, annual quantity of processible wastes bypassed to the landfill, energy output, and incremental capital costs versus incremental energy revenues; 4) selection of appropriate turbine-generator set and appurtenances; 5) preparation of interconnecting standards and specifications estimates of plant emission loads (air

and water) and identification of appropriate levels of pollution control technology; 6) preparation of mass and energy balances; and 7) definition of an appropriate ash handling system. Associated with this activity, system performance specifications would be developed for inclusion in a procurement document. System acceptance test criteria also would be prepared as part of this task for subsequent inclusion in a procurement document.

In the event the Authority determines that it cannot sign up a sufficient number of private haulers or that negotiations for the sale of electricity to either Fort Benning or Georgia Power will cause substantial delays, it will be necessary to redefine the project. The economic viability of either a large steam project (without electricity generation) or a smaller project, with or without electricity generation, will need to be established.

3. Facility Site Analysis

The site designated by Fort Benning for the energy recovery facility will require analysis to determine the most appropriate site utilization. Geological, topographic and other site data will be required, including selected soils boring data. These data are necessary for bidders to make firm construction price bids. In addition, special design circulation and landscape treatment requirements will need to be identified in cooperation with Fort Benning personnel.

4. Environmental Assessment and Permit Requirements

Although the results of a preliminary investigation indicated that a full Environmental Impact Statement (EIS) is not required, this will need to be verified with Fort Benning. Such verification should be made because making a site available on Federal property may be construed as a Federal action requiring an EIW. If an EIS is not required for Federal purposes, an environmental assessment may be required. Under any case, all actions required to mitigate short- and long-term harm to the environment should be identified by the Authority and established as requirements to be met during construction and operation of the energy recovery facility.

A permit plan and schedule should be prepared so that all required permit applications are identified and information requirements established. Depending upon the Authority's selection of a procurement approach, it may be possible to assign most, if not all, the responsibility for preparation of permit applications to a contractor.

5. System Procurement

There are three methods of procurement used for energy recovery projects. Each of these approaches differs in the ability of the Authority to transfer technical risks associated with a waste-to-energy facility from itself to the private sector. Choice of the appropriate procurement method will be affected in large measure by the decision of Fort Ben-Benning as to whether or not it wants to operate the energy recovery facility. If Fort Benning does not insist upon the right to operate the facility, the Authority's choice of procurement approach will be affected by its decision whether or not it wants to own the energy recovery facility. As the preliminary economics presented in Chapter 5 indicate, a cogeneration facility involving private ownership appears to offer the lowest net disposal cost. In considering private ownership, the Authority will need to decide whether it wants a long-term waste disposal service arrangement or a firm interested in the design, construction, and operation of a manufacturing plant. The distinction between these two approaches is significant and affects not only the structure of the procurement document, but the substance of the contractual arrangement between the Authority and the facility owner. Contractually the major difference between the two approaches to private ownership will be reflected in the degree of assumption of risks and liabilities by the private owner. Whether or not the choice of private ownership is open to the Authority will depend upon key decisions by Fort Benning to two questions. First, will Fort Benning permit a privately owned, but publicly sponsored, energy recovery facility to be located on its property? Second, will Fort Benning contract for the sale of steam and electricity with a private company? If the answer to either of these questions is "no," then private ownership of the energy recovery facility may not be a viable option for the Authority.

The three methods of procurement used for energy recovery projects are:

- An architectural and engineering (A&E) contract, which is customary for facility design and equipment selection, preparation of competitive bid specifications, construction supervision, and, possibly, facility shakedown. Construction and equipment installation are competitively bid. Owner takes title to the plant upon its physical completion. Shakedown and full-scale operation are the responsibility of the public owner.

- A turnkey approach, in which a single entity performs the services that would otherwise be provided by an A & E, plus construction, testing, and shakedown of the system. Final payment is made to the turnkey contractor following successful shakedown and acceptance by the public sponsor. Full-scale operation is the responsibility of the public owner.

- A full-service approach, in which a single contractor performs all functions of a turnkey contractor and is responsible for full-scale operation of the facility (generally ranging from 5 to 20 years). The owner does not take over the plant until the acceptance test has been passed. The full-service contractor provides system performance guarantees over the life of the contract and is subject to substantial penalties for default on these guarantees.

The table below summarizes the extent to which project risks can be transferred from the Authority to private industry under the procurement approaches.

Key Project Risks	A&E	Turnkey	Full Service
Project economics	None	Limited	Substantial
Marketing	None	None	Substantial
System Performance	Very Limited	Limited	Substantial
Waste Stream	None	None	Limited

The full-service approach offers the maximum opportunity to contractually transfer much of the risks associated with an energy recovery project to the private sector. The major risks which will be difficult to totally transfer under a full-service approach are: 1) changes in waste quantity and composition, 2) events of force majeure, and 3) changes in law requiring

additional capital outlays and/or increases in annual operating and maintenance costs. A full-service procurement may be undertaken with either public or private ownership. Because of the ability to transfer much of the technical risks to the vendor under a full-service approach, the Authority should give serious consideration to this approach.

Once the Authority has made the basic decisions as to public versus private ownership and method of procurement, it will have to make the following key decisions prior to preparation and issuance of a procurement document:

- Whether to procure a system on a sole source or competitive negotiated basis, and whether to use a Request for Qualifications to narrow the potential number of bidders to those most qualified to respond to a complete procurement document.
- What performance guarantees to require of the operator and the type and level of penalties for operator non-performance.
- How to deal with issues of force majeure and changes in law during construction and during facility operation.
- What incentives, if any, will be offered to the facility operator to maximize energy revenues while maintaining performance guarantees and the maintenance of the facility.
- Definition of the responsibilities of the Authority, Fort Benning, and the vendor during the operating period.
- Determination of the specific plan for financing the project, including the flow of project funds to various accounts and the priority of that flow of funds.
- Definition of the role of Fort Benning (and Corps of Engineers) in preparation of the procurement document, evaluation of proposals, and selection of the preferred proposer with which to contract.

Based upon decisions by the Authority on the above, the Authority will have to prepare a procurement document covering the technical and business requirements to which proposers must respond. Upon receipt of proposals, the Authority will need to evaluate responses on a systematic and well documented basis, make a selection, and enter into contract negotiations.

It should be clear from the above brief discussion of procurement that considerable effort and resources will have to be expended by the Authority to properly structure and carry out the procurement effort in a cost-effective manner, and in a manner that will provide the best means of assuring that the public interest is well served.

6. Project Financing

As stated at the beginning of this chapter, the Authority must use revenue bonds to finance an energy recovery project. It is important that the Authority recognize the fact that revenue bonds issued for resource recovery projects are considered a specialty item within the revenue bond market. As such, revenue bonds issued for the Authority's project will require a special marketing effort by the investment banking firm selected for bond underwriting. Because several large energy recovery projects have had well publicized startup problems, many of the institutional investors who purchase tax-exempt bonds have become nervous about purchasing revenue bonds issued for recovery projects. Thus, it will be extremely important that the Authority structure its energy recovery project to provide prospective bond buyers with the maximum confidence in the financial soundness and security of the project.

The Authority has no independent source of raising revenues outside of those generated from the sale of energy and disposal fees; hence it cannot be a source of financial security to investors. As a result, the key issue for the Authority is how to provide the required security to ensure that principle and interest will be paid if project revenues fall below that necessary to make such payments. The four principal causes of a revenue shortfall are: 1) a technical deficiency in the performance of the system; 2) the supply of waste to be processed is significantly below that planned for; 3) the energy buyer does not take the energy output of the facility; or 4) a force majeure event cripples the recovery plant or the ability of the energy buyer to take plant output.

The contractual arrangements with the system vendor, the Consolidated Government, and Fort Benning can provide coverage for the first three potential causes of revenue shortfall. The major problem will be how to provide coverage for an event of force majeure. A debt service

reserve fund and insurance can provide a major source of funds for payment of debt service. However, if the force majeure event is substantial, those two sources may be insufficient to cover debt service over the period required to correct the condition caused by force majeure. Furthermore, if the debt reserve fund is drawn down, it will need to be replenished. The question which must be answered is: Will the Consolidated Government directly back the bond issue through a pledge to make up any draw-down of the debt service reserve fund, or indirectly through agreement to pay whatever increase in the tip fee may be required, or both?

7. Organization and Funding of Authority

To accomplish the above tasks and deal with the related issues, the Authority cannot be passive but must take the initiative in carrying out the proposed project. It will need its own staff and budget. It also should utilize where appropriate, the services of various agencies of the Consolidated Government. Because a successful project financing requires a suitable structuring of relationships among the various participants, centralized expertise, responsibility and leadership should be housed within the Authority.

Hiring the kind of talent required to manage project implementation takes time. Therefore, the Board of Directors should begin recruitment as early as possible. The Board in undertaking staff recruitment should consider how much of the effort should be done in-house, by staff contributions from the Consolidated Government, and through the use of qualified consultants experienced in energy recovery project implementation.

The authority will have to set a budget and secure funding to carry out the implementation effort. Lacking independent power to raise money, and being a new organization formed under fairly recent innovative state legislation may present problems for the Authority, unless the City of Columbus is prepared to make an initial loan. The Authority should consider passing a bond inducement resolution so that its expenditures for implementation can be capitalized and recovered from the proceeds of the project bond issue.

In addition to immediate funding requirements, the Authority should begin to consider ways to finance its future operational requirements. It is important to realize that in many ways the main activities of the Authority begin after the recovery project is financed. Under the terms of the City ordinance activating the Authority, it becomes responsible for solid waste disposal once the energy recovery facility is operational. This means that the Authority must secure and, if need be, operate, a landfill for disposal of residue from the recovery facility as well as non-processible wastes that go directly to landfill. Thus, besides overseeing and monitoring the operation of the energy recovery facility, it also must do the same for a landfill operation. Both activities will require staff and budget.

APPENDIX A.

MUNICIPAL COLLECTION PRACTICES: PRELIMINARY EVALUATION

A preliminary evaluation of the solid waste collection practices of Columbus was conducted to determine the efficiency and cost effectiveness of the collection system. From this evaluation, potential areas for improvement were identified. The remainder of this section describes current collection practices, discusses the analytical approach used in evaluating the Columbus collection system, and identifies potential areas for improvement.

SYSTEM DESCRIPTION

Several aspects of the Columbus system are different from typical municipal refuse collection systems. (The basic characteristics and operation of the Columbus system are summarized in Table A-1.) For example, 24 of the 36 collection crews are staffed with convicts from the State prisons. The driver of each convict crew is a certified, gun-carrying prison guard, and the two walkers are convicts. The convicts are picked up at the prison each morning and returned after work. There have been a limited number of escape attempts from the convict collection crews.

Unlike other systems, each Columbus crew collects refuse from most of the commercial, as well as all the residential locations. Each route includes an average of 20 commercial stops (1,400 city-wide). Commercial refuse is dumped into 4 to 8 cu yd bins, which in turn are deposited into rear-load packers with cable winches. The Columbus people believe that combined commercial/residential collection is more cost-effective than separate pickups. About 700 of the larger commercial and industrial locations within the City are serviced by contract haulers.

Most municipal collection systems use separate vehicles to pick up large bulky refuse such as appliances and old furniture. The Columbus system finds it more cost-effective to pick up anything that fits

in the packer without harming the equipment. According to crew members, they regularly pick up items such as refrigerators and washing machines with packer trucks. One crew picked up and compacted a full-size sofa during the site visit.

SYSTEM EVALUATION

A solid waste collection system typically is evaluated by two related but independent criteria: productivity and cost effectiveness. Ideally, in evaluating the Columbus collection system, comparison would be made with other communities with similar collection practices such as system equipment and crew size and comparable circumstances in terms of population served, urban nature, and geographic locale. However, finding collection data from communities with closely parallel circumstances is problematic. For the purpose of this preliminary evaluation, two collection systems previously judged to be highly productive and cost-effective were selected for comparison with Columbus. The two systems selected are Birmingham, Alabama, where collection system was evaluated during an earlier U.S. EPA Technical Assistance Project; and System A, which was studied during a 1-year EPA evaluation of residential collection systems.

As previously stated, both Birmingham and System A were found to be highly productive and cost-effective. Both privide two pickups per week, use rear load packers, and make a single pass along most routes. Major differences to be noted between these referenced systems and Columbus is that Birmingham utilizes 4-person crews; collects garbage (household refuse) from residents twice per week but trash (landscape and miscellaneous) only once per week; collects only a portion of the commercial sector waste; and in certain parts of the city provides only alley pick-up and not door-to-door service. While System A utilizes 3-person crews as does Columbus, it does not provide collection to commercial accounts.

The approximate productivity of the Columbus system is 122 pickups/crew-hour or 61 pickups/walker-hour. (See Table A-2.) These estimates are based on route time and other information provided by Columbus personnel. Productivity data for System A and Birmingham in terms of pickup/

walker-hour were found to be 100 and 104, respectively. Although the Columbus collection system appears to be 39 percent less efficient than System A and 41 percent less efficient that Birmingham, three factors must be emphasized. First, as previously noted, there are major differences between the three systems in terms of level of service, as only Columbus collects a major portion of the commercial sector waste, a time-consuming effort. Second, contributing to Columbus' apparent lower productivity is its practive of using convicts, who have relatively little incentive to work productively. In contrast, time/motion measurements of two nonconvict crews indicated a productivity level of about 200 pickups/crew-hr (pickup counts for 1-hr period). This productivity level is comparable to both System A and Birmingham. Finally, Columbus is being evaluated against two systems determined to be highly productive.

However, in terms of cost effectiveness the Columbus collection system is clearly the least costly of the three systems reviewed. (See Table A-4.) Columbus has a considerably lower per-capita collection cost than the three comparable systems. The per-capita collection cost for Columbus is about 25 percent lower than Birmingham's, even though the Birmingham system is about twice as productive. Convict labor seems to be the major factor reducing the Columbus system's cost (each convict is paid $9/wk).

POTENTIAL AREAS FOR IMPROVEMENT

The identification of three possible areas for improved efficiency and reduced costs was based on two assumptions:

1. Columbus wishes to maintain the same level of service; as a result, possible efficiency or cost savings measures predicated upon substantially reduced levels of service were not considered.
2. Columbus can devise politically acceptable methods that provide incentives to the convict-staffed crews to improve their efficiency.

The following options are ranked in likely order of effect:

- Implement an incentive program to improve convict-staffed crew productivity.

- Assign all commercial accounts to designated commercial routes.
- Optimize system macro and micro routing.

Obviously, before implementation, each of these options must be evaluated further to verify their potential merit. Each of these options is discussed in the following sections.

Convict Crew Incentive Program

A program to encourage more productivity from convict-staffed crews is based on the objective of increasing pickups from 75/hr to at least 113/hr (a 50-percent improvement in efficiency).* At present, nonconvict crews complete an average of 150 pickups/hr (some crews have been observed to complete as many as 200/hr). Using the 150-pickup/hr average, convict crews are 50 percent less efficient than nonconvict crews.

If the efficiency of convict-staffed crews improved by 50 percent, Columbus could eliminate as many as 8 trucks and convict crews. The incremental costs of conducting the incentive program (and possibly increased fuel requirements) could be substantially lower than equipment, maintenance, and other costs incurred by the 8 eliminated convict-staffed crews.

Separate Commercial Pickups

Assigning all commercial accounts to designated commercial routes will require the purchase of several expensive 40 cu yd front-end collection vehicles and also may require the replacement of existing dumpsters. However, such vehicles can be staffed by a single driver and are far more efficient in servicing commercial-type accounts. However, if commercial accounts are scattered over a wide area, the potential advantage of such an approach is diluted.

The feasibility of commercial-only pickups depends on two major variables:

- The need to replace dumpster (Columbus could also consider requiring all commercial accounts that want

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* It is not the intent of this section to address the sociopolitical implications of paying incentives to prisoners whose labor is viewed as a way of repaying their debts to society.

continued free collection service to purchase a compatible dumpster).

- The number of city employees and trucks that can be eliminated as a result of decreased workload.

Macro/Micro Routing

Columbus' management personnel plans to evaluate existing system macro and micro routing in the near future. The Columbus management anticipates that optimized routing could eliminate as many as six crews. While it is difficult to quantify potential crew reductions, at the very least, improved system routing will reduce vehicle maintenance and gas consumption because fewer miles will be traveled.

TABLE A-1
COLUMBUS REFUSE COLLECTION SYSTEM

Level of Service

- Curb/alley refuse placement
- Twice-per-week collection
- Bulky waste collection (appliances, furniture)

Crew Composition

- One (1) driver/crew chief per crew
- Two (2) walkers per crew
- 36 collection crews (12 city, 24 convict)

Collection Equipment

- Rear-load packer vehicles
- 25-cu-yd refuse capacity
- 46 packers (36 duty, 10 reserve)

TABLE A-2
ESTIMATED PRODUCTIVITY OF
COLUMBUS REFUSE COLLECTION SYSTEM

Service-Related Productivity[1]

- Estimate of weekly on-route time for the 36 Columbus crews

  1,000 crew-hr/wk

  27.8 crew-hrs per wk ÷ 5 = 5.6 hrs/day

- Estimate of pickup locations (residences and businesses)

  61,000

- Calculation of productivity for twice-per-week collection

  $\frac{2 \times 61,000}{1,000}$ = 122 pickup/crew-hr

Tonnage-Related Productivity[2]

- Waste collected per week

  1,620 ton/wk

- Calculation of productivity

  $\frac{1,620}{1,000}$ = 1.6 ton/crew-hr

(1) Estimates of on-route time and pickup locations are based on information provided by City of Columbus personnel.

(2) Tonnage figures from recent landfill weighing program.

TABLE A-3

PRODUCTIVITY OF REFUSE COLLECTION SYSTEMS

SYSTEM	CREW SIZE	CREW PRODUCTIVITY (pickup/crew-hr)	WALKER PRODUCTIVITY (pickup/walker-hr)
Columbus	3	122	61
A	3	200	100
Birmingham	4	311	104

Note: Productivity is based on on-route hours. Data for System A taken from Residential Collection Systems, Volume 1, EPA/530/SW-97c. 1, U.S. EPA, 1974. Data for Birmingham taken from "Technical Assistance to the City of Birmingham, Alabama," U.S. EPA, October 1980.

TABLE A-4

COMPARISON OF REFUSE COLLECTION SYSTEM COSTS

City	Population (1980)	Projected Refuse Collection Cost (FY 82)	Projected Per-Capita Collection Cost
Columbus, GA.	159,000	$1,700,000	12
Savannah, GA.	148,000	3,600,000	24
Macon, GA.	117,000	2,600,000	22
Birmingham, AL.	268,000	4,200,000 *	16

Note: Data for Columbus, Savannah, and Macon provided by City of Columbus personnel. Data for Birmingham is from 1978-1979 estimate made by City of Birmingham. Projections of 1982 costs based on information provided by City of Birmingham.

* Includes amortization of equipment.

APPENDIX B.
SITE EVALUATION CRITERIA
FOR MUNICIPAL SANITARY LANDFILLS

In addition to exploring resource recovery options, the Consolidated Government of Columbus is also exploring the intermediate and long-term feasibility of implementing and operating one or more environmentally complying landfill disposal facilities. The following section discusses the major engineering, environmental, legal and regulatory, political, and economic considerations that should be addressed in implementing a landfill disposal facility.

ENGINEERING AND CONSTRUCTION CONSIDERATIONS

The key engineering and construction factors that must be considered when siting a sanitary landfill include:

- Physical size
- Proximity to the waste source
- Site access
- Topography
- Geology
- Site conditions.

The candidate site should have sufficient acreage to accommodate the waste generated by the community(ies) served for at least 10 years and preferably more than 20. The acreage requirements of a given site are affected by the landfill operational practices, including disposal method (i.e., cell or trench vs. area method); degree of in-place compaction and daily cover; and site topography and soil conditions.

The ideal active disposal area is a minimum of 100 ft of unoccupied space that serves as a buffer zone between the site and the nearest off-site activity. Current or planned materials recovery, baling, or other methods of reducing waste volume should be taken into account when determining the necessary capacity and acreage of the landfill site.

To minimize waste transportation costs, the selected site should be near the waste source or sources. Although a nearby site may be more expensive to acquire and to operate than a more remote site, it may be justified because of the reduced cost of hauling.

The site should have a sufficient number of access roads to ensure accessibility. Wide roads must have adequate load capacity; traffic congestion should be avoided.

The site's existing topography is a key factor in designing landfill development to minimize excavation costs. Careful site selection will reduce the costs of diverting surface drainage away from the active disposal area.

Geotechnical hazard areas (such as those prone to slides and faults), as well as areas with underlying, adjacent, or interconnected mines, quarries, sinkholes, or solution cavities should be avoided. The underlying geological strata should be structurally strong enough to support the fill as well as necessary surface structures such as dams or embankments.

Low permeability soils to inhibit leachate from entering the groundwater system are desirable landfill site features. Clays and clayey soils are generally advantageous. Soils with good attenuative capacity also tend to prevent groundwater contamination. The characteristics of the natural soils of any prospective site should be tested with soil borings to evaluate the need for brining in off-site materials for landfill construction.

ENVIRONMENTAL CONSIDERATIONS

Four key environmental factors should be considered in siting a sanitary landfill:

- Surface and groundwater hydrology
- Air
- Terrestrial and aquatic ecology
- Noise.

Surface and groundwater hydrology are important factors in landfill siting. The disposal area should be located to prevent inundation by flood waters from rivers and creeks. Swamps, wetlands, seeps and springs should be avoided. If no optimal site is available, the landfill design should include plans to divert surface water away from the disposal area. Minimizing the surface water on site will reduce the operational problems of leachate abatement and erosion control.

Contamination of the groundwater by landfill leachate should be prevented, particularly if the site overlies an aquifer that is or could be used as a water supply. Groundwater contamination is less likely to occur where the bottom of the landfill is separated by at least 5 ft from the seasonal high groundwater table.

Low permeability soils tend to prevent leachate from moving from the fill to the groundwater system. As the fill is completed, a low permeability cap and cover will minimize water infiltration into the fill and reduce leachate generation. The potential effect on existing water supplies should be considered in the site location (EPA guidelines recommend a 500-ft distance between the disposal site and existing groundwater and surface water supplies). In addition, groundwater infiltration should be minimized by selecting a site away from critical groundwater recharge areas.

Wind intensity and direction must be considered to minimize the effects of wind erosion and odor emissions.

The alteration of unique terrestrial or aquatic ecology should avoided. No rare or endangered species (resident or migratory) should be threatened by the landfill location.

The local impacts from noise by transportation, construction, and operation should be minimized.

LEGAL AND REGULATORY CONSIDERATIONS

A potential landfill site is subject to legal and regulatory constraints and thus must be politically and publicly acceptable. The relevant regulatory agencies should be contacted early in the site-selection process to determine permitting and monitoring requirements. Early

contacts with regulatory agencies may identify issues that must be resolved before permits may be successfully processed.

The number and types of required permits and certficates will vary, depending on site size, location, and scope. The following list is representative of permitting requirements:

Local: County health department permit (for disposal operation and sanitary facilities)

Zoning variance (for construction and dumping)

Soil and water conservation district (permit for construction)

State: Solid waste disposal permit (for disposal operation)

Health department permit (for sanitary facilities)

Stream encroachment permit (for rerouting streams or stream crossings)

Highway department permit (to relocate or build new roads)

Soil erosion and sediment control plans (for construction)

Dikes and dams permits (for construction and safety)

Discharge permits (for pond overflow)

Federal: Environmental Protection Agency (NPDES permits)

Corps of Engineers (Section 404 permits, navigable waters permits)

POLITICAL AND PUBLIC ACCEPTANCE CONSIDERATIONS

Political and public acceptance of the new disposal site must be achieved before a landfill facility can be successfully acquired, developed, and operated. Local elected officials such as county commissions, mayors, and supervisors must accept the disposal site. The public at large, including special interest groups such as sportsmen's clubs, nature clubs, and environmental groups, must also approve the site

selection, and design and operation. In many cases, it is necessary to conduct a public information and public relations program concurrent with the site selection process to win political and public acceptance of the project.

ECONOMIC CONSIDERATIONS

The development of a waste disposal site involves more than site acquisition costs. The following list includes some of the economic issues that must be considered in evaluating alternative disposal sites.

- Relative transportation costs from waste collection area to disposal site.
- Property acquisition costs (land costs plus legal fees, realtor commissions, and other indirect costs).
- Site development costs (such construction costs as excavation, grading, and new roads).
- Annual costs (relative merits of high fixed annual charges and low operating costs or low fixed annual charges and higher operating costs).
- Closure costs (expense of the final covering of the site and preparing it for subsequent land use).
- Salvage value (if the site is restored to a productive state after filling, salvage value will be an asset).

APPENDIX C
ENERGY MARKET SURVEY RESULTS

The results of the energy market survey are presented in the following subsections for:

- Columbus Carpet Mills
- Fieldcrest Mills
- Georgia Power Company
- Swift Textiles.

COLUMBUS CARPET MILLS

Columbus Carpet Mills is a small mill employing about 300 persons. Two boilers are used to raise 125-psia, 450°F steam -- one rated at 36,000 pounds per hour and the other at 42,000 pounds per hour. Normal mill operation is three shifts per day, 5 days per week. However, for a 6-week period between late May and mid-July, the plant operates on a 4-day week. This lack of continuous operation decreases significantly the amount of energy from municipal waste that could be utilized at this location. The Columbus Carpet Mills as an energy market is also constrained by the fact that siting of a resource recovery plant would probably require acquisition of property nearby, but not adjacent to, the mill.

FIELDCREST MILLS

Fieldcrest Mills' Columbus facilities include two plants with a total employment of about 1,300 persons. The plants operate 24 hours per day, 306 days per year, and produce towels.

The Fieldcrest complex has two separate steam plants about 1,000 feet apart. These plants raise steam primarily for dyeing and blending, and for space heating, as needed. The E&P steam plant has two units rated at 60,000 pounds per hour and one at 50,000 pounds per hour. The

14th Street steam plant has two units each rated at 60,000 pounds per hour. One boiler at each location is used for standby purposes.

Steam at both plants is raised at 125 psia, 350°F. The combined steam load for two 24-hour periods was 1,395,000 pounds and 1,260,000 pounds. Natural gas is the primary fuel used, with some use of No. 6 oil. The oldest boiler in the two plants was installed in 1939. Other units began service in 1948 and 1957. There do not appear to be any plans for boiler replacement or for expansion of the steam plants in the near term.

Assuming that each ton of municipal waste yields 6 million Btu, Fieldcrest's steam demand could consume the energy equivalent of 360 TPD_5 to 400 TPD_5. With this level of demand, Fieldcrest is a potentially attractive customer.

A study is in progress to examine the feasibility of enlarging a 3.5-MW hydro plant on the river to 15-20 MW. The electrical output would be used internally by Fieldcrest with the balance sold to Georgia Power.

Expansion of Fieldcrest Mills prohibits siting a resource recovery plant within the Columbus complex. Sites within close proximity appear, from brief inspection, to be unavailable. In addition, Fieldcrest representatives expressed a strong concern for reliability and a definite preference for company control of its steam generating supply.

GEORGIA POWER COMPANY

Georgia Power Company was contacted to determine the potential feasibility of selling electricity from a municipal energy recovery facility to the Georgia Power system. Two factors appear negative.

First, Georgia Power currently has excess capacity and, because of its relatively lower electrical generation rates compared to those in an adjacent state and other regions of the United States, may soon be an exporter of electricity. Thus, from a capacity standpoint, Georgia Power

does have a compelling incentive to purchase electricity from small power producers.

Secondly, Georgia Power has a relatively low avoided cost. The company does not have any oil-fired power plants; the generating units are coal-fired and nuclear with some hydro. In addition, because the system does not need any more capacity, the avoided cost is not upwardly influenced by the capital cost of new plant construction. In addition, Georgia Power has recommended a "split savings" approach whereby the small power producer and the utility would split any avoided cost savings. Georgia Power does have and is not required to publish a standard avoided cost rate. However, company officials report that the average "split savings" among existing agreements with small power producers has been 0.011 mills per kWh, slightly more than 1.0¢ per kWh.

The combination of excess capacity and a low avoided cost range as the basis for negotiation of electricity price and of future project revenues makes Georgia Power Company an unattractive sole-source customer for a municipal waste-to-energy plant in Columbus.

SWIFT TEXTILES, INC.

Located in Columbus, Swift produces textiles and blue denim and employs about 1,000 persons. Normal plant operations are 24 hours per day, 6 days per week. However, 1 week each month the energy plant operates on a 5-day week.

Swift normally operates two boilers, one rated at 60,000 pounds per hour and the other at 40,000 pounds per hour. The plant also has a smaller boiler on standby. The boilers raise steam at 125 psia, 400^{o}F. Swift's steam plant uses natural gas supplied under an interruptible contract. Swift relies on No. 6 oil for backup.

Swift's average electrical demand is 5 million kWh per month, with peak demand in the summer.

Given Swift's annual steam demand, this market could accept less

than half of the energy output from a plant processing 490 tons of per day on a 5 day basis.

The Swift plant is located in downtown Columbus, where there appear to be no adequate sites for a resource recovery facility. The siting problem, along with Swift's steam demand and the lack of continuous operation precluded Swift from further consideration as a buyer of energy from a municipal waste-to-energy facility.